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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Detecting a content item in a digital video stream

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Detecting a content item in a digital video stream

The invention relates to a method of detecting a boundary of a content item in a digital video stream. The invention also relates to a device for detecting a boundary of a content item in a digital video stream. The invention further relates to a receiver for receiving at least one content item in a digital broadcast video stream, and a video recorder for recording at least one TV program.

US patent application US2002/0186768 describes a method of content detection based on data obtained in a process of compressing video, e.g. by a MPEG encoder. The MPEG encoder encodes video data from a TV broadcaster, the Internet, etc. The MPEG encoder generates the data such as a current bit rate value combined with a quantizer value to indicate fast varying or very complex scenes in the video, e.g. to indicate visual complex pictures or pictures containing fast motion. This encoding bit rate measures an amount of bits required for encoding a piece of video, and it usually increases for fast moving pictures and visually complex scenes.

However, the encoding bit rate can not reliably indicate, for example, whether the video comes from a movie containing fast motion or a commercial with fast moving scenes. The known method can not reliably indicate a boundary of a content item using the encoding bit rate. Moreover, the method known from US2002/0186768 can be used only when the MPEG encoder is available.

It is an object of the present invention to obviate the drawbacks of the known method, and to provide a method of detecting the boundary of a content item in a digital video stream which is more reliable and can be used without any MPEG encoder.

This object is realized in that the method of the present invention comprises the steps of:

- determining an average bit-rate of the video stream over a period of time, and

- detecting a change of the average bit-rate indicating the boundary of the content item.

The content items may vary in their quality and, hence, bit rates. For example, commercials may have higher bit rate because companies usually pay for high-quality advertisement material. In case of a broadcast digital video stream, broadcasters may, for example, keep the bit rate of a channel constant but allocate different bit rates to content items according to a type of content.

The bit-rate is a rate of data allocated to a content item in the digital video stream may be determined. The bit-rate may be indicated as additional information in the digital stream. For example, in the digital video broadcasting (DVB) a number of streams carrying video, audio, control data formed into packets of a certain type may be transmitted. With the video data in the packets having a predetermined or indicated size, it is possible to determine the bit rate of the video stream.

The average bit rate may be calculated in various ways, e.g. simply for successive periods of time or, alternatively, a moving average of the bit rate may be determined. Of course, other manners of calculating a value of the bit rate over a period of time may be envisaged.

The boundary of the content item may be ascertained based on detecting the change of the average bit rate, for example, by determining a deviation of the average bit rate value exceeding a predetermined threshold, a deviation of the change of the average bit rate value exceeding a certain percentage of said value, etc.

The present invention has an advantage that the average bit rate is more reliable and robust than the encoding bit rate known in prior art. The determination of the average bit rate over the period of time smoothes variations which are not indicating real changes in the type of content.

A further problem associated with the known method of content detection is found when the content is in an encrypted digital stream. The method known in the prior art document US2002/0186768 can not be applied to the encrypted digital stream. This known method would require decrypting the stream, decoding it to uncompress the stream and re-encoding the stream to compute the encoding bit stream. The known method can be applied only to MPEG data representing groups of pictures in the stream, and it is based on a mean absolute difference (MAD) value. This MAD value represents an average of magnitudes of vectors used to describe movement of video blocks in frames. Obviously, this information is not accessible in the encoded video stream.

In turn, the method of detecting the boundary of the content item according to the present invention can be applied to the encrypted digital video stream. The method is based on the average bit rate of the stream and it is not affected substantially in case of the encrypted stream.

The method of the present invention has an advantage that it works fast for the encrypted streams, i.e. the average bit rate can be easily calculated also for the encrypted streams without any decryption. Moreover, if the boundary of the content item in the encrypted stream is detected, only a part of the digital encrypted stream belonging to the content item may need to be decrypted for further purposes such as recording the content item, the rest of the stream need not be decrypted.

In one of the embodiments, the method of the present invention can be applied in an Electronic Program Guide (EPG) of the TV system. In the EPG, broadcast schedule data (EPG data) indicating a beginning and/or end of broadcasting at least one content item may be available in advance, i.e. before the broadcast of the content item. According to the method of the present invention, the detection of the boundary of the content item may be used for verifying whether the EPG data are in accordance with the detected boundary of a respective content item in the video stream. This may be utilized in a video recorder for precisely controlling the beginning and end of recording the broadcast content item.

The object of the present invention is also realized in that the invention provides for the device for detecting a boundary of a content item in a digital video stream, the device comprising:

- means for determining an average bit-rate of the video stream over a period of time,
- means for detecting a change of the average bit-rate indicating the boundary of the content item.

Said device may be incorporated into a receiver for receiving at least one content item in a digital broadcast video stream; or a video recorder for recording at least one TV program, comprising such a receiver and means for recording the TV program based on its detected boundary in the video stream.

These and other aspects of the invention will be further elucidated and described with reference to the accompanying drawings, wherein:

Fig. 1 shows an embodiment of the method of the present invention;

Fig. 2 depicts a diagram showing an example of the calculated average bit rate of the video stream;

Fig. 3 depicts an enlarged diagram showing an example of the calculated average bit rate at the end of the content item;

Fig. 4 shows a diagram illustrating operation of the device suitable for implementing the present invention.

Fig. 1 shows an embodiment of a method of detecting a boundary of a content item in a digital video stream. The video stream may be obtained by reading out information from a data carrier such as a CD-ROM disk (Compact Disk Read Only Memory), a DVD disk (Digital Versatile Disk), a magnetic carrier, etc. Alternatively, the video data may be received in a known manner from a video broadcaster, e.g. using digital video broadcasting (DVB), video on demand systems, the Internet, etc.

The bit rate of the video stream may be determined at step 110. The video stream is usually packetized and kept in so-called frames. The frames may have a header and a body, and the header comprises information about the data contained in the body. The header may indicate information related to a bit rate usually expressed as the number of bits transmitted per second. For example, the digital stream, according to the MPEG standard, obtained using the DVB broadcasting or from the DVD disk track may contain a plurality of the packetized elementary streams. The packets of the elementary stream may be of a fixed or variable size. The packets may have different types and belong to different elementary streams. Therefore, packets belonging to elementary streams carrying pay load information, e.g. so-called transport streams, may need to be filtered out. The fixed-size packet of the transport stream may comprise, for example, 184B of payload and 4B of the header.

In another example, the video stream may be obtained in a Digital Video (DV) standard. For instance, DV packets may be obtained from a DV equipment, e.g. a DV camcoder or a DV recorder, via IEEE1394 protocol (commonly known as FireWire). In the DV format, a video frame according to the NTSC (National Television System Committee) video method (525 lines/frame, 30 video frames per second) consists of 1500 DV blocks that have the size of 80B. The DV/IEEE1394 packets obtained from the DV equipment may have a format with a header of 12B and a body of 480B (6 DV blocks). Thus, the video frame may comprise 250 DV blocks. Having this information, it is possible to determine the bit-rate of

the video stream obtained from such DV equipment. The bit rate of the video stream in other formats may be computed.

At step 120, a period of time is determined for calculating an average bit rate of the video stream. The period may be pre-set to a value of several seconds, two-five seconds or more (step 121). Alternatively, the period of time may be variable. For example, shot cuts, e.g. scene changes, in the video content item may be detected at step 125 and the period of time may be adjusted to the detected shot-cuts accordingly at step 126, so that a particular period of time may be equal to a period between scene changes. In a further example, if the time period between detected scene changes is too large, e.g. exceeding some pre-set maximum threshold, it may be split into shorter time periods over which the average bit rate may be calculated. The changes of scene may be determined, for example, using a scene change detector known from a document EP1,006,685. The scene change detector calculates an inverse correlation value of successive frame images. The correlation value is estimated based on absolute values of differences between pixel values of corresponding pixels of the images. The scene change is determined when the correlation value exceeds a predetermined threshold value. Fast motion detectors known in the prior art may also be used for detecting scene changes. When the video stream is encoded, partial decoding of the stream to obtain distribution of the headers of the packets and detect the scene changes may be sufficient, without complete decoding of the video stream, e.g. the MPEG stream.

At next step 130, the average bit rate of the video stream over the determined period of time may be estimated in different manners. The average bit rate may be computed by adding values of the bit rate over the determined period of time and dividing the sum by the number of values. In another example, a moving average bit rate may be calculated, e.g. mean value calculated over a rolling previous period of fixed length. The average of the bit rate may smooth small variations of the bit rate that are, e.g., due to noise instead of real boundary of the content item, and real changes in the type of content.

By detecting a change of the determined average bit rate, a boundary of the content item may be found at step 140. For example, a threshold bit rate value may be compared with the determined average bit rate, and the boundary of the content item may be determined if the threshold value is exceeded. The threshold value may be fixed or variable. For example, the threshold value may be a percentage of the average bit rate within which it may change with respect to the values of the average bit rate calculated for the previous period or several preceding periods. In this case, the absolute value of the threshold for average bit rate is not fixed. In another example, a first derivative of the values of the average

bit rate for consecutive periods of time may be estimated to detect the rapid change of the average bit rate.

When the period of time for calculating the average bit rate is not short enough for determining the boundary of the content item with acceptable accuracy, e.g. half of a second, one second, etc, a position of the detected boundary of the content item within the corresponding period of time may be determined at step 150. The position of the boundary may be determined by comparing the values of the bit rate for progressive frames in the video stream; by partitioning the given period of time into small segments and comparing the average bit rate values for each successive segment with the period of time in which the boundary of the content item is determined, or in other manners.

In Fig. 2, the average bit rate of the video stream calculated for the TV program "Presumed Innocent" received from digital broadcast is shown. The duration of the program is approximately 2 hours and 55 minutes. The begin and end time of broadcasting the program were based on a TV program guide (EPG) and extended for a few minutes. The real beginning and end of the program and commercial blocks are highlighted. The vertical axis in Figs. 2 and 3 reports the average bit rate in kbits per second and the horizontal axis reports the progressive frame number.

In this example, the average bit rate shown in Fig. 2 changes dramatically during program boundaries and commercial blocks. The average bit rate changed considerably in the beginning of the program, especially in the first 1500 frames. Three commercials in the program also caused a lot of changes in the average bit rate. Finally, the average bit rate changed significantly at the end of the program as it is shown in Figure 3. Figure 3 shows changes of the average bit rate within a thousand of video frames at the end of the program. These changes may be caused by splicers used by providers of the video content to insert digital content such as commercials into the video content which might had already been digitized, without the need for expensive decoding and re-encoding that can reduce the quality of content.

Typically, the TV broadcasters or other providers of content insert the commercial blocks in different content items in a similar way, for example, in the beginning and/or end, and may be several times in the middle of the content items. This pattern of a particular typical positioning of the commercials within the content items may be learnt by a device for detecting the boundary of the content item, and used for reliably determining whether the detected change of the average bit rate indicates the commercial block of the content item. Moreover, known methods of recognizing commercial blocks based on

analyzing audio and/or video features of the content item may be used for verifying whether the detected boundary belongs to the commercial.

The method of detecting the boundary of the content item as described above can also be applied to encrypted video stream with content items. Most digital video streams, e.g. PayTV and Pay per View, are packetized in the conventional manner but the packets are encrypted using specific keys and methods. Conditional access systems adopted by broadcasters and set-top box manufacturers do not allow performing any operation on the stream but decoding in real time for viewing. The handling of encrypted streams will become very relevant for all products that have storage.

The method according to the present invention can be applied to the encrypted streams because it is based on the average bit rate over the particular period of time and the encryption of the stream does not affect substantially the average bit rate. There is no need for decrypting the video stream to detect the boundary of the content item. If necessary, the encrypted video stream may be decrypted only in its parts where the boundary has been detected. This is more efficient and less data-processing intensive than decrypting or decoding the whole stream to detect the boundary of the content item.

The average bit rate of the encrypted stream may be calculated, for example, by extracting the payload of the stream from the headers of the packets. For example, if the DVB stream is scrambled, the headers may be not encoded, as it is described for scrambling and conditional access systems in the book "Digital Television: MPEG-1, MPEG-2 and principles of the DVB system", by H. Benoit, 1997, Arnold (chapter 5, pages 75-80).

With reference to Figure 4, an embodiment of a device for detecting the boundary of the content item in the digital video stream is shown. The device may comprise a processor 410 arranged for processing the video stream and determining an average bit rate of the video stream over the period of time, and a detector 420 for detecting the change of the average bit rate indicating the boundary of the content item.

The processor 410 may be arranged to perform steps 110 to 130 of the method of the present invention as described above. The processor may be implemented by the person skilled in the art in the known manner, e.g. the processor can be provided with a memory for storing instructions to be executed by the processor for enabling it to function correspondingly. The detector 420 may be arranged to carry out operations disclosed above with reference to step 140 of the present method. The detector may be implemented using the same processor 410 or, for example, the detector may be a separate circuit arranged for

comparing the average bit rate determined by the processor with the threshold bit rate value, and generating a signal indicating that the boundary of the content item has been detected.

The processor 410 may be coupled to a receiver 430 for receiving at least one content item in the digital broadcast video stream, e.g. TV tuner, DVB-T or DVB-S receiver. Such a tuner/receiver may be conventional and implemented as well known in the art.

The device may be coupled to a recorder 440 for recording the TV program based on the detected boundary of the program in the stream. The recorder may be arranged to record the TV program based on broadcast schedule data, e.g. the EPG data indicating the beginning and end of the program. However, it may happen that the program is received by the receiver not according the schedule and the recorder will record not required content. This may be obviated by means of the device for detecting the boundary of the content item as described above. The device may be arranged for verifying whether the broadcast schedule data are in accordance with the detected boundary of a respective content item. If there is some difference in time between said detected boundary and the schedule data, i.e. the content item is actually received later or earlier than the schedule data indicate, the recorder may be instructed to start recording the content item at the position where the boundary is determined. Furthermore, if the commercial blocks are detected in the stream by the device, the recorder may be instructed to skip them, and only the actual content item will be recorded.

The various program products may implement the functions of the device and method of the present invention and may be combined in several ways with the hardware or located in different other devices. Variations and modifications of the described embodiment are possible within the scope of the inventive concept. Thus, for example, the use of the verb 'to comprise' and its conjugations does not exclude the presence of elements or steps other than those defined in a claim. The invention can be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means can be embodied by one and the same item of hardware.

CLAIMS:

1. A method of detecting a boundary of a content item in a digital video stream, the method comprising the steps of:
- determining (130) an average bit-rate of the video stream over a period of time, and
- detecting (140) a change of the average bit-rate indicating the boundary of the content item.

2. The method of claim 1, wherein the content item is in a digital broadcast video stream.

3. The method of claim 1, comprising the steps of:
- detecting (125) shot-cuts in the content item, and
- adjusting (126) the period of time to the detected shot-cuts.

4. The method of claim 1, wherein a moving average of bit-rate is determined.

5. The method of claim 1, wherein the content item is a commercial.

6. The method of claim 1, wherein the digital video stream is MPEG compressed.

7. The method of claim 1, wherein the content item is in an encrypted digital video stream.

8. The method of claim 1, further comprising the steps of:
- obtaining broadcast schedule data indicating a beginning and/or end of broadcasting at least one content item,
- verifying whether said broadcast schedule data are in accordance with the detected boundary of a respective content item in the video stream.

9. The method of claim 1, further comprising a step (150) of determining a position of the detected boundary of the content item within a corresponding period of time.

10. A device for detecting a boundary of a content item in a digital video stream, the device comprising:

- means (410) for determining an average bit-rate of the video stream over a period of time,
- means (420) for detecting a change of the average bit-rate indicating the boundary of the content item.

11. A receiver for receiving at least one content item in a digital broadcast video stream, comprising the device as claimed in claim 10.

12. A video recorder for recording at least one TV program, comprising:

- a receiver (430) for receiving at least one TV program in a digital video stream,
- the device as claimed in claim 10 in which the content item is the TV program, and
- means (440) for recording the TV program based on its detected boundary in the video stream.

13. A computer program product enabling a programmable device when executing said computer program product to function as the device as defined in claim 10.

ABSTRACT:

The invention relates to a method of detecting a boundary of a content item in a digital video stream. The method comprises the steps of determining (130) an average bit-rate of the video stream over a period of time, and detecting (140) a change of the average bit-rate indicating the boundary of the content item. A moving average of the bit-rate may be determined. The method can be used for an encrypted digital video stream. The invention also relates to a device for detecting a boundary of a content item in a digital video stream. The invention further relates to a receiver for receiving at least one content item in a digital broadcast video stream, and a video recorder for recording at least one TV program.

Fig. 1

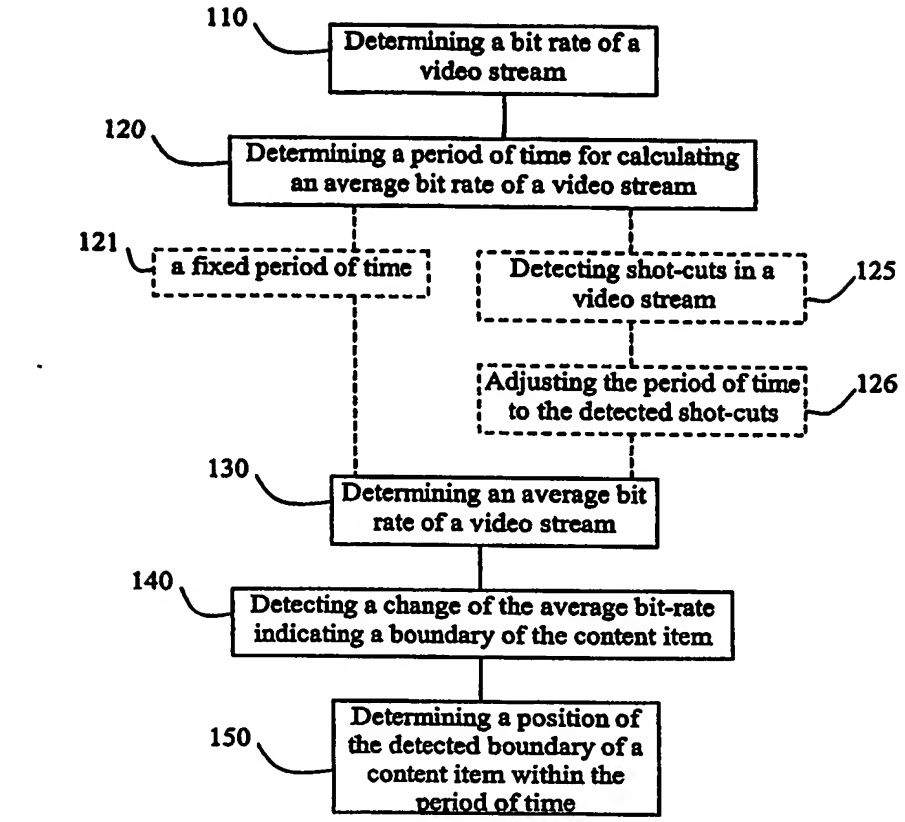
110
Determining a bit rate of a video stream
120
Determining a period of time for calculating an average bit rate of a video stream
121
a fixed period of time
Detecting shot-cuts in a video stream
125
Adjusting the period of time to the detected shot-cuts
126
130
Determining an average bit rate of a video stream
140
Detecting a change of the average bit-rate indicating a boundary of the content item
150
Determining a position of the detected boundary of a content item within the period of time

FIG.1

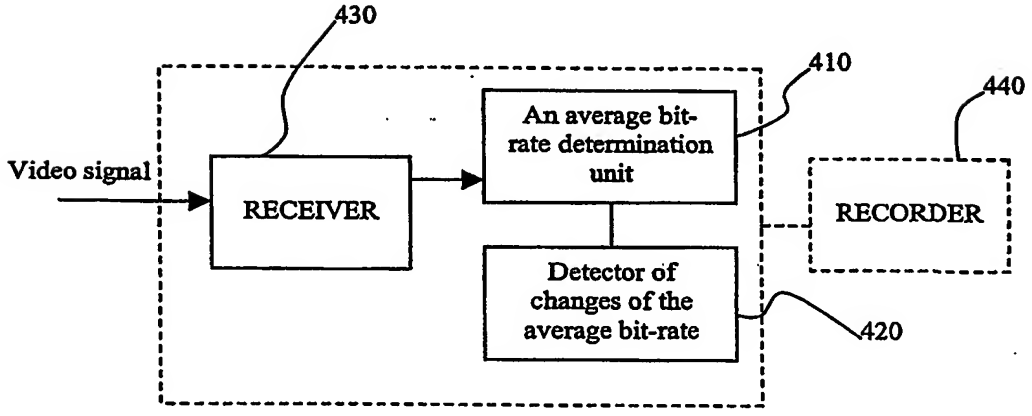
430
410
440
Video signal
RECEIVER
An average bit-rate determination unit
RECORDER
Detector of changes of the average bit-rate
420

FIG.4

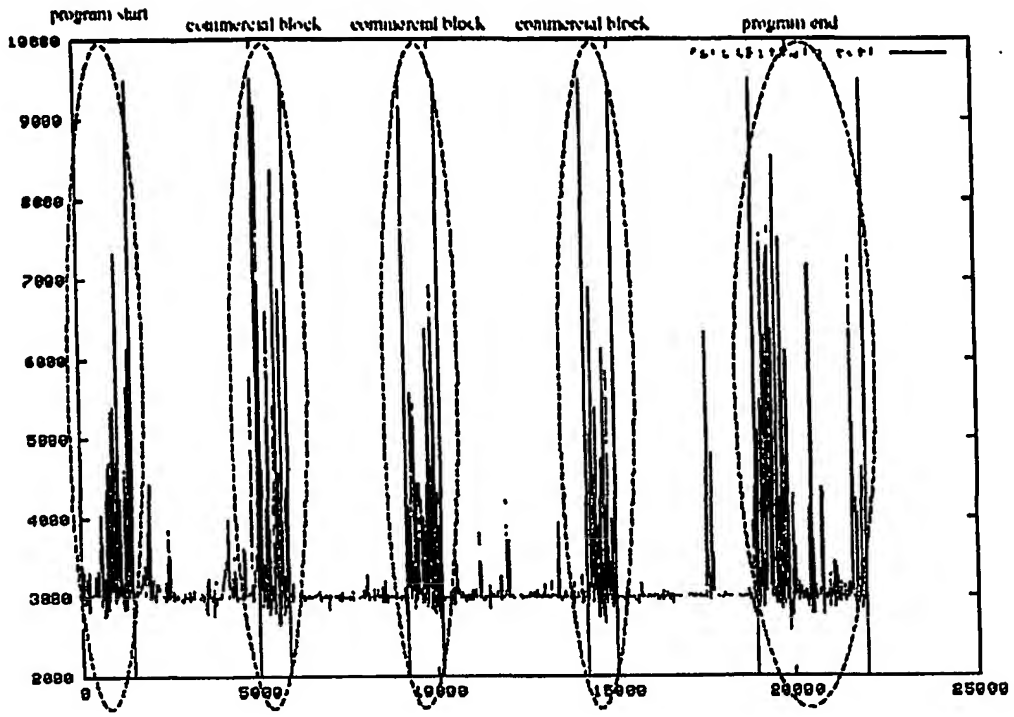
program start
commercial block
commercial block
commercial block
program end
10000
9000
8000
7000
6000
5000
4000
3000
2000
0
5000
10000
15000
20000
25000

FIG.2

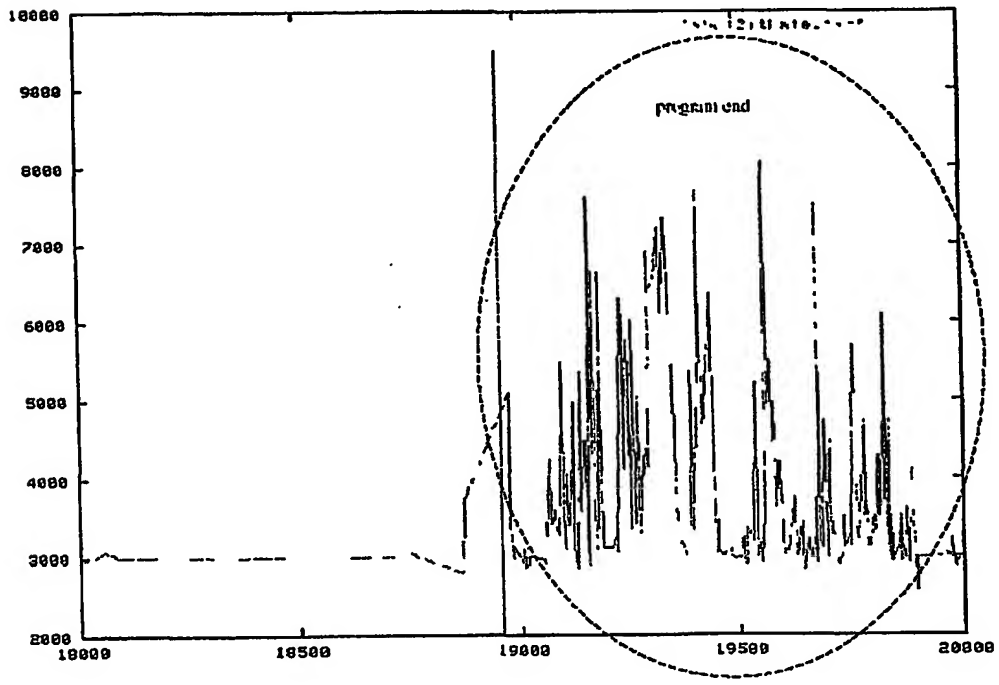
program end
10000
9000
8000
7000
6000
5000
4000
3000
2000
18000
18500
19000
19500
20000

FIG.3

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